THE UNIVERSITY OF ARIZONA

COLLEGE OF AGRICULTURE AND LIFE SCIENCES

COOPERATIVE EXTENSION

Resistant Palmer Amaranth in Arizona

Blase Evancho
Assistant-in-Extension
Field Crops

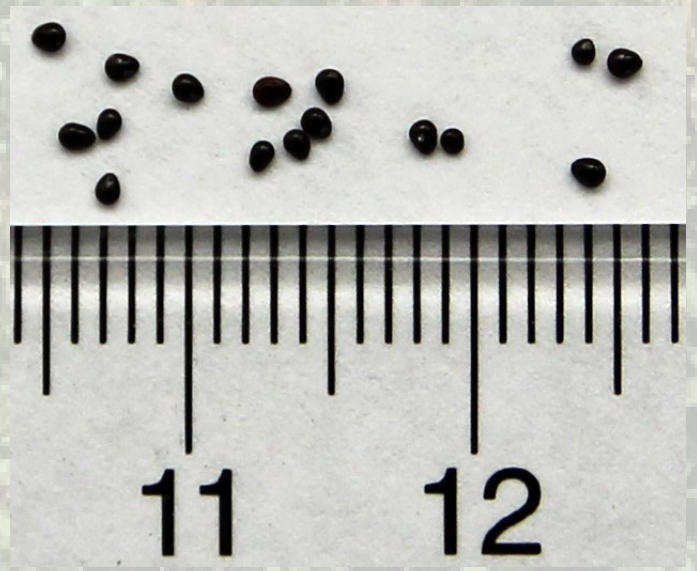
2021 Winter Field Crops Clinic
1/26/2021

Photo credit: Bill McCloskey, University of Arizona (above & right)

Palmer amaranth (Carelessweed,Pigweed)

Robust dioecious annual reproduces by seed.
Seed production = 600,000 to 1.6 million seeds per large female.
An infestation can produce 375 million seeds per foot of crop row
Long-term seedbank longevity unknown, but lost 85% viability after 3 years.

Palmer amaranth seeds



Male Palmer amaranth - Male flowers with yellow anther sacs

Palmer amaranth is dioecious – obligate outcrosser

Female Palmer amaranth flowers

Photo credits: Bill McCloskey, University of Arizona

Male Palmer amaranth - Male flowers with yellow anther sacs

Glyphosate resistance can move in pollen and seed!

Female Palmer amaranth flowers

Photo credits: Bill McCloskey, University of Arizona

Palmer Amaranth & ivyleaf morningglory competition with cotton (2 leaf) following simultaneous emergence

Photo credit: Bill McCloskey, University of Arizona (above)

Palmer Amaranth – Rapid Growth (C_4)

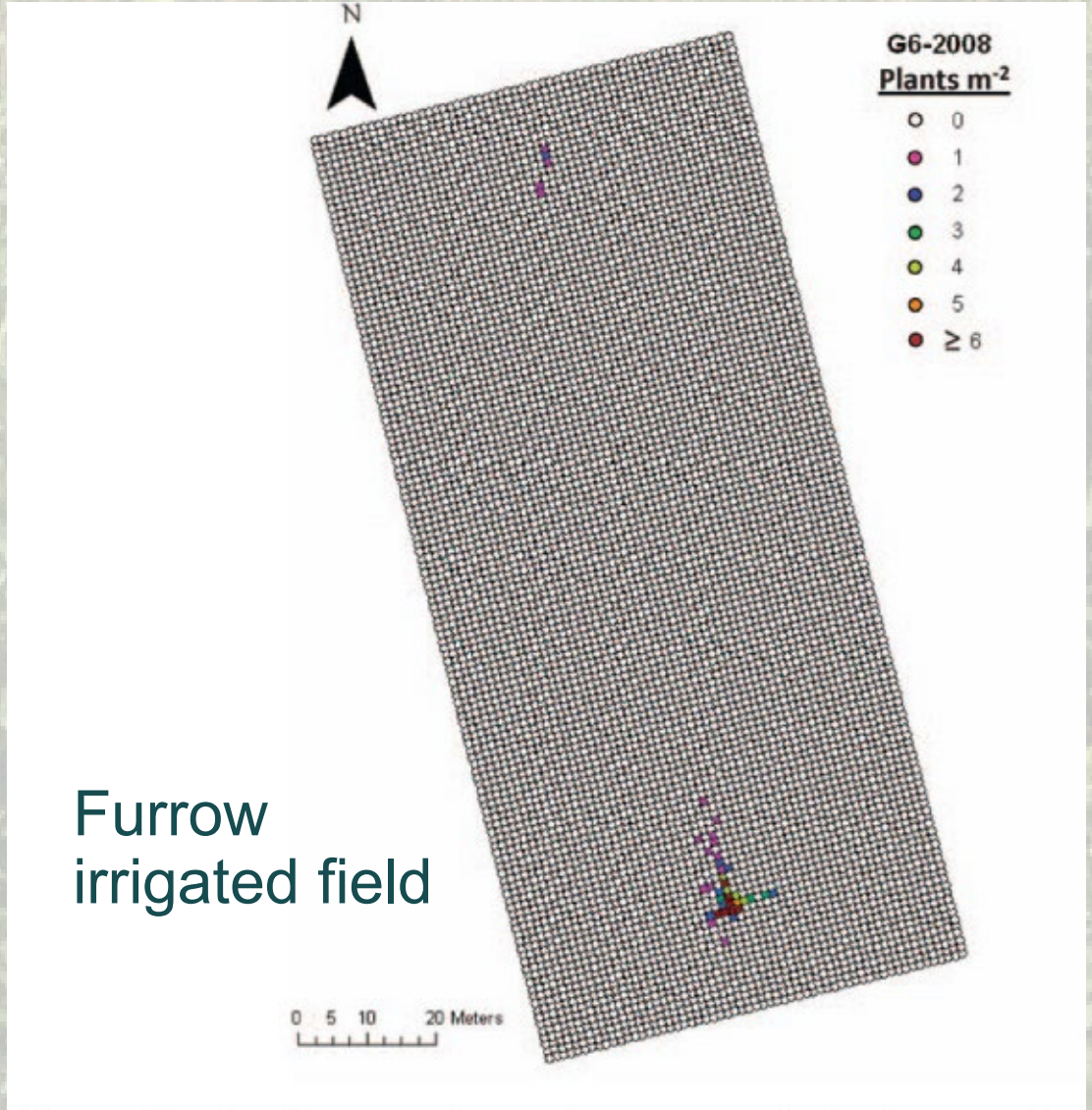
Photo credit: Bill McCloskey, University of Arizona (above)

- Rapid growth rate
- C_4 photosynthesis (uses all available light)
- >80 µmol CO_2 m^2 s^{-1} compared to 35 µmol CO_2 m^2 s^{-1} for cotton (Photosynthesis = 2.3 x cotton)
- High temperature growth optimum
- Greater water use efficiency

In-Field Movement of Glyphosate-Resistant Palmer Amaranth and its Impact on Cotton Lint Yield: Evidence Supporting a Zero-Threshold Strategy.

Norsworthy et al., Weed Science 2014 62:237-249

- Year 1 (2008)
  - 20,000 seed/1 m^2 circle (February)
  - Palmer infested 0.56% of field area
  - No yield loss



Furrow irrigated field

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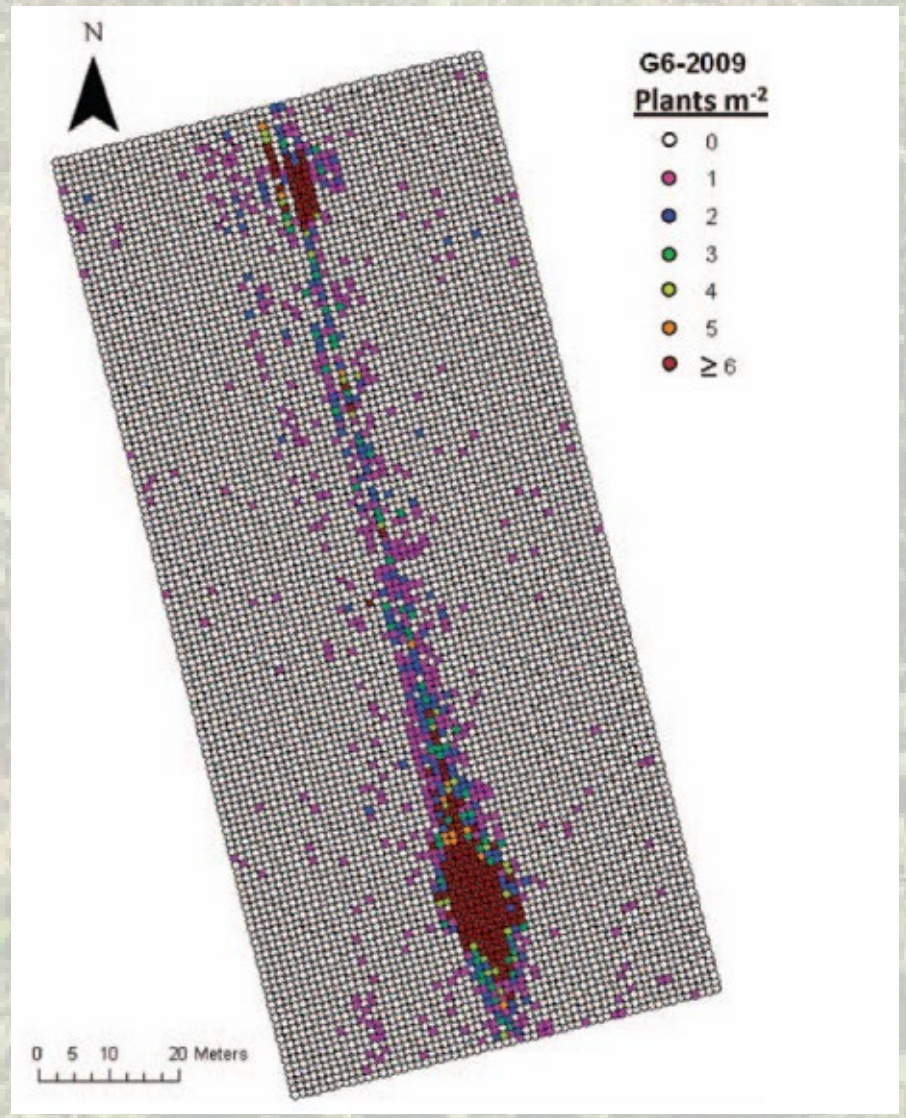
Photo credit: Blase Evancho, University of Arizona



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- Year 3 (2010)
  - Palmer infested 95 to 100% of field
  - No lint yield/field was not physically harvestable

Tactics that may control and delay or avoid developing herbicide resistant weeds

Herbicides	Mechanical	Cultural
Multiple herbicides with different mechanisms of action	Tillage	Crop rotation
Mixes	*Pre-plant*	Plant population
Sequences	In-crop cultivation	Row spacing
Across seasons	In-row weeding	Planting date
	Post-harvest	Fertilizer placement
	Hand-rogueing before seed set	Cover crops

Prowl H_20 (0.95 lb/A) applied PPI (field cultivator, listed, mulched, bed-shaped)

Photo credits: Bill McCloskey, University of Arizona

PREE- & POST-Emergence Selective Cotton Herbicides (use with appropriate traits)

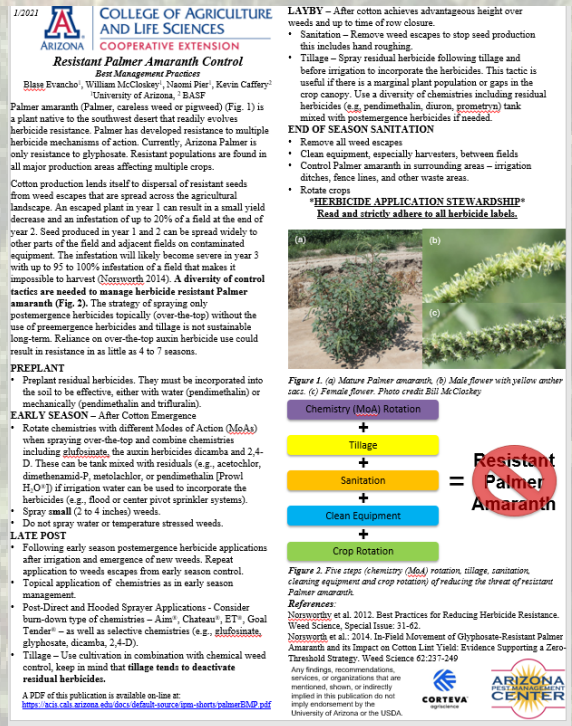
Preplant – Residual Herbicides	Early POST – Mid POST (sequential sprays) Selective Chemistries (with appropriate varieties)
*Pendimethalin	Dual Magnum (metolachlor) Warrant (acetochlor) Outlook (dimethenamid-P)
*Trifluralin	Pendimethalin (microencapsulated H2O formulations)
*Prometryn	Glyphosate
*Diuron	Glufosinate (Liberty, Interline)
*Solicam	2,4-D-choline (Enlist One) 2,4-D-choline+glyphosate (Enlist Duo)
*Rates depend on soil type – consult labels	Dicamba (Engenia, Xtendimax)
	Pyrithiobac (Staple LX), Trifloxysulfuron (Envoke)
	Graminicides: fluazifop, sethoxydim, clethodim (Fusilade, Poast, Select)

Mid-Post & Layby Herbicides (non-selective)

Post-Directed Herbicides	Soil Activity	Mid-POST: 6 to 15 inches tall Layby: 15 to 24 inches tall or greater
Aim	NO	1 to 1.6 fl. oz./A – do not spray green stems Post-direct at crop base or use shields @ 6-12″ cotton
Chateau	Yes	1-2 oz./A for post-direct burndown 2 oz./A @ layby on all soil types
Diuron	Yes	6-8″ – 0.4 lb. a.i./A (0.4 qt./A) 8-12″ – 0.6 lb. a.i./A >12″ – 0.8-1.2 to 0.8-1.6 lb. ai./A based on soil type
ET	NO	0.5 to 1 fl. oz./A – do not spray green stems Post-direct at crop base or use shields @ 6-12″ cotton
Oxyfluorfen	Yes	>6-8″ – 0.5 lb. a.i./A; can apply 2 times/season
Prometryn	Yes	>6″ – 0.5-0.65 lb. a.i./A >12″ – 1.2-1.6 lb. a.i./A on sandy loam soils >12″ – 1.6 lb. a.i./A on loam and heavier soils
Consider tank-mixes		PPO inhibitors (Aim, ET) + prometryn or diuron Glyphosate + either prometryn, diuron, or glufosinate

Cotton Post-Direct and Layby Herbicides

Layby PD broadcast	PREE soil activity	Foliar Herbicide type/activity	General Crop Rotation intervals
Prowl H_2O (pendimethalin)	Yes	None	Medium-Long
Prometryn	Yes	Contact	Short
Diuron	Yes	Contact	Long
Goal, GoalTender (oxyfluorfen)	Yes	Contact	Long-small grains, Short labeled crops
Chateau (flumioxazin)	YES	Contact	Short with tillage
Fierce (flumioxazin + pyroxasulfone)	YES	Contact	Long
Aim (carfentrazone)	NO	Contact	None-registered crops
ET (pyraflufen)	NO	Contact	Short (30 days)



1/2021 ARIZONA COLLEGE OF AGRICULTURE AND LIFE SCIENCES COOPERATIVE EXTENSION

Resistant Palmer Amaranth Control

Best Management Practices

Blaise Evancho[1], William McCloskey[1], Naomi Pier[1], Kevin Caffery[2]
[1]University of Arizona, [2] EASF

Palmer amaranth (Palmer, careless weed or pigweed) (Fig. 1) is a plant native to the southwest desert that readily evolves herbicide resistance. Palmer has developed resistance to multiple herbicide mechanisms of action. Currently, Arizona Palmer is only resistance to glyphosate. Resistant populations are found in all major production areas affecting multiple crops.

Cotton production lends itself to dispersal of resistant seeds from weed escapes that are spread across the agricultural landscape. An escaped plant in year 1 can result in a small yield decrease and an infestation of up to 20% of a field at the end of year 2. Seed produced in year 1 and 2 can be spread widely to other parts of the field and adjacent fields on contaminated equipment. The infestation will likely become severe in year 3 with up to 95 to 100% infestation of a field that makes it impossible to harvest (Norsworth 2014). **A diversity of control tactics are needed to manage herbicide resistant Palmer amaranth (Fig. 2).** The strategy of spraying only postemergence herbicides topically (over-the-top) without the use of preemergence herbicides and tillage is not sustainable long-term. Reliance on over-the-top auxin herbicide use could result in resistance in as little as 4 to 7 seasons.

PREPLANT

- Preplant residual herbicides. They must be incorporated into the soil to be effective, either with water (pendimethalin) or mechanically (pendimethalin and trifluralin).

EARLY SEASON – After Cotton Emergence

- Rotate chemistries with different Modes of Action (MoAs) when spraying over-the-top and combine chemistries including glufosinate, the auxin herbicides dicamba and 2,4-D. These can be tank mixed with residuals (e.g., acetochlor, dimethenamid-P, metolachlor, or pendimethalin [Prowl H_2O®]) if irrigation water can be used to incorporate the herbicides (e.g., flood or center pivot sprinkler systems).
- Spray **small** (2 to 4 inches) weeds.
- Do not spray water or temperature stressed weeds.

LATE POST

- Following early season postemergence herbicide applications after irrigation and emergence of new weeds. Repeat application to weeds escapes from early season control.
- Topical application of chemistries as in early season management.
- Post-Direct and Hooded Sprayer Applications - Consider burn-down type of chemistries – Aim®, Chateau®, ET®, Goal Tender® – as well as selective chemistries (e.g., glufosinate, glyphosate, dicamba, 2,4-D).
- Tillage – Use cultivation in combination with chemical weed control, keep in mind that **tillage tends to deactivate residual herbicides.**

A PDF of this publication is available on-line at: https://acis.cals.arizona.edu/docs/default-source/ipm-shorts/palmerBMP.pdf

LAYBY – After cotton achieves advantageous height over weeds and up to time of row closure.

- Sanitation – Remove weed escapes to stop seed production this includes hand roughing.
- Tillage – Spray residual herbicide following tillage and before irrigation to incorporate the herbicides. This tactic is useful if there is a marginal plant population or gaps in the crop canopy. Use a diversity of chemistries including residual herbicides (e.g, pendimethalin, diuron, prometryn) tank mixed with postemergence herbicides if needed.

END OF SEASON SANITATION

- Remove all weed escapes
- Clean equipment, especially harvesters, between fields
- Control Palmer amaranth in surrounding areas – irrigation ditches, fence lines, and other waste areas.
- Rotate crops

HERBICIDE APPLICATION STEWARDSHIP

Read and strictly adhere to all herbicide labels.

Figure 1. (a) Mature Palmer amaranth, (b) Male flower with yellow anther sacs. (c) Female flower. Photo credit Bill McCloskey

Figure 2. Five steps (chemistry (MoA) rotation, tillage, sanitation, cleaning equipment and crop rotation) of reducing the threat of resistant Palmer amaranth.

References:

Norsworthy et al. 2012. Best Practices for Reducing Herbicide Resistance. Weed Science, Special Issue: 31-62.
Norsworth et al.: 2014. In-Field Movement of Glyphosate-Resistant Palmer Amaranth and its Impact on Cotton Lint Yield: Evidence Supporting a Zero-Threshold Strategy. Weed Science 62:237-249

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ARIZONA PEST MANAGEMENT CENTER

Resistant Palmer Task Force

- Produce & share information on herbicide resistant Palmer amaranth to attempt to slow and contain pest.
- Monitor and inventory this pest in our agricultural landscape.
- Incentivize IPM tools that will make the largest impacts.

Thank you to all collaborators and supporters

Arizona Cotton Growers Association

ARIZONA COTTON RESEARCH AND PROTECTION COUNCIL

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